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Quarterly Progress Report 2

Radar Studies of the Moon

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FOREWORD

This report presents a summary of progress primarily in the engineering and checkout of the dual-channel receiver configuration for the Haystack planetary radar. This configuration is required to permit the simultaneous mapping in two orthogonal polarizations of the entire lunar surface at the high ($\approx 2 \times 2$ km) resolution available with Haystack at 3.8-cm wavelength.

It is anticipated that the next report will cover the actual beginning of mapping measurements.

RADAR STUDIES OF THE MOON

I. SUMMARY

During this quarter, the instrumentation of the two-channel radar receiver was substantially completed. The present schedule calls for mounting the Planetary Radar (PR) Box, including an operational two-channel receiver, on the 120-foot antenna on 21 October for four weeks of planetary observations. Much of that period will be occupied with tests of the dual-channel system. An intensive mapping operation will begin in January when the PR Box again is mounted on the antenna.

The first-phase (real-time) and second-phase (Fourier transform) computer programs have been rewritten to process the multiplexed two-polarization data and produce one pre-mapping tape for each polarization. As a result, the third-phase (mapping) program can be used without change.

II. DUAL-CHANNEL RECEIVER

In tests late in September, the maser invariably developed a thick coating of frost and held its temperature for only 6 hours or less, instead of the 10- to 12-hour hold time that was anticipated. There were, in addition, several other problems that suggested a disassembly and rework. This work was carried out at the end of September with good results. The new two-channel maser has now been completed and is being tested.

The major alteration made during the rework comprised the bonding of the copper heat-exchange baffles to the input and output waveguides. This was intended to provide better transfer of the waveguide heat to the outflowing cold helium gas. Some other minor revisions were also necessary. The latest tests of the dual maser are summarized in Table I, together with figures affording a comparison with the original single maser. At this writing, the maser is being installed in the PR Box in preparation for the beginning of radar experimentation on 21 October.

TABLE I MASER CHARACTERISTICS JUST PRIOR TO PR BOX INSTALLATION					
Maser	Excess Noise Temperature (°K)	Gain (db)	Pump Power (mw)	Pump Frequency (GHz)	Helium Hold Time (hr)
"Polarized" Channel	18	31	70	20.565	>6
"Depolarized" Channel	16	29	70	20.565	>6
Original Single Maser	10	32	170	20.565	20

III. RECEIVER CALIBRATION, RF PROTECTION, AND BACK END

Figure 1 is a diagram of the 3.8-cm circuitry in the dual receiver. From the antenna at the right, the two polarizations split and travel via independent channels through the dual maser and mixer-preamps to the ground-based portions of the receiver. Two paths are available between antenna and maser. The one used for the lunar mapping is the inner path that utilizes a ferrite switch and pulsed attenuator for high-speed protection of the receiver from stray transmitter power. Two possible noise-source calibration signals are available. One of these is followed by a fast switch (located approximately in the center of the diagram) that can provide a brief calibration pulse for each radar pulse interval. It is expected that the use of such a calibration procedure will permit both the mapping and the lunar scattering law data to be obtained from the same set of observations. The scattering law, of course, provides the baseline for all the sub-maps, but has not yet been measured for the depolarized return at this wavelength.

The direct outer path between antenna and maser is used for planetary radar and some receive-only operations, where fast protection is not needed. The experimenter, therefore, is happy to eliminate the extra 40° system temperature contribution of the switched path.

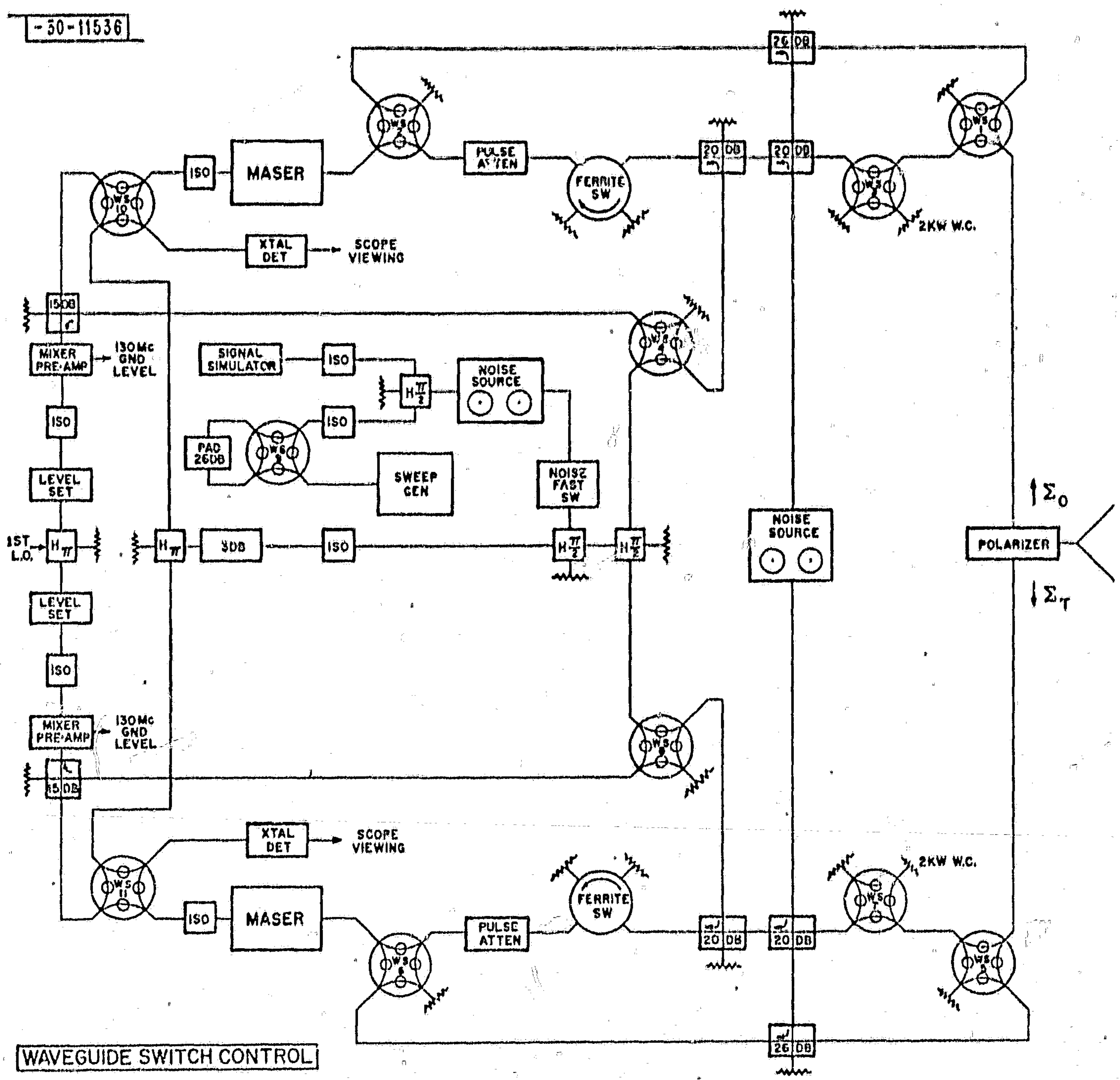

Fig. 1. Receiver waveguide configuration.

The rest of the diagram includes the twin 130-MHz mixer-preamps and the sweep and simulator equipment for tuning up the maser, and for other general testing and alignment.

IV. COMPUTER PROGRAMMING

The original mapping of the equatorial region of the moon made use of three phases of computer programming: the real-time, the Fourier transformation, and the final calibration and assembly. For the present work, it seems most efficient to retain the final phase intact by providing for it separate successive inputs for the polarized and depolarized data.

The first phase is mainly a data handling program that is already working near the speed limit of the CDC 3300 computer. It cannot, therefore, be changed drastically. Those changes which will be needed to provide the test director with a quick look at the quality of the data have already been made.

The Fourier transform program, consequently, carries the major load of changes for the two-polarization mapping task. Although the program has been entirely rewritten once, it is felt that further work is necessary. At present, it is expected that 7 to 10 hours of phase 2 processing time will be required for every one of the 200 or so hours of antenna time needed for the complete mapping program. Completion of this work by the end of June will impose a heavy burden on our computer facility unless the time needed for the second phase can be reduced by another rewrite of the program – a possibility now being studied. No delays to the observing schedule will result.

V. PLANS FOR NEXT QUARTER

As mentioned above, the first radar measurements with the new system will be made during the three-week period beginning 21 October. Most of that time will be spent in testing and calibrating the new system both internally and on radio sources. If the system proves to be sufficiently reliable, lunar observations will be started during that time, with priority to the equatorial regions for comparison with earlier work. The next radar operations are scheduled to begin shortly after the beginning of 1969, and full-scale lunar data gathering will begin at that time.